ORIGINAL ARTICLE

Injuries from paintball game related activities in the United States, 1997–2001

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Objective: To quantify and characterize injuries resulting from paintball game related activities among persons ⩾7 years in the United States.
Setting: Hospitals included in the National Electronic Injury Surveillance System (NEISS); these are composed of a stratified probability sample of all hospitals in the United States with emergency departments.
Methods: Using NEISS, non-fatal injury data for paintball game related injury cases from 1997–2001 were obtained from emergency department records. Participation estimates used to calculate injury rates were obtained from a yearly survey funded by the National Sporting Goods Association.
Results: An estimated 11 998 persons ⩾7 years with paintball game related injuries were treated in emergency departments from 1997–2001, with an annual average rate of 4.5 per 10 000 participants (95% confidence interval 3.3 to 5.7). The paintball game related injury rate was highest for 18–24 year olds (4.9 per 10 000 participants) and most injuries (94.0%) occurred among males. Almost 60% of all injured persons ⩾7 years were treated for paintball pellet wounds of which most were to the eye. While 76.9% of injured persons ages 7–17 years were treated for paintball pellet wounds, almost 40% of those ⩾18 years were treated for injuries resulting from overexertion or a fall. Lower extremity injuries were also common (23.0%), mostly from overexertion. Most injured persons (95.5%) were treated and released.
Conclusions: As paintball games become more popular, efforts are needed to increase training, enforce rules, and educate participants about how to stay safe, such as wearing protective eye gear, when engaged in paintball games at home, in a public area, or in a sports field.

Paintball guns and the associated paintball pellets were originally developed for use by foresters to mark trees to be cut down. In the early 1980s, they were adapted for use in a combat simulated sport, which has evolved into paintball games.[1 2] Over the last 15 years, this sport using paintball markers has increased in popularity. These games usually involve two competing teams that try to capture each other's flag while shooting one another with paintballs fired from carbon dioxide powered guns. When paintballs strike participants, they are marked with paint and they must leave the game. The paintball games were originally played in paintball sports fields and the equipment was rented. As a result of increased popularity,[1–3] the paintball guns have become available for purchase online, at sporting goods stores, and at department stores that sell sporting goods. Participants now commonly play the game in the woods, in other public areas, and around the house (that is, "backyard" games), in addition to paintball sports fields.

A primary health concern regarding paintball game related sports has been the risk of injury to the eye. These carbon dioxide powered guns can fire paintball pellets at speeds up to 300 ft/sec. Paintball pellets—gelatin capsules filled with non-toxic, water soluble paint that are approximately 17 mm in diameter—are designed to break on impact. When they hit the eye, injury can result causing reduced visual acuity, or even blindness.[1] Numerous case studies have reported on ocular injuries resulting from a projected paintball. Some of these studies have indicated that the incidence of eye injuries has increased because more people are using paintball guns in informal settings where, unlike organized facilities, the use of eye protective devices or goggles and face protection equipment is not required.[1–3]

Population based data have not been available to allow national estimates of the number of paintball game related injuries or to characterize these injuries and injury circumstances in the population in the United States until recently.[4] Also, little has been reported regarding injuries other than those caused by a projected paintball, such as sprained ankles resulting from darting in and out while playing paintball games. This study provides the first national estimates of paintball game related injuries treated in hospital emergency departments in the United States for persons of all ages. It provides a more comprehensive summary of the demographic characteristics of those injured, the types of injuries, and circumstances (for example, activity, cause, and locale where injured) associated with paintball game related activities.

METHODS

As part of a special study of all gun related injuries, paintball game related injury data from 1997–2001 were obtained through the National Electronic Injury Surveillance System (NEISS), operated by the United States Consumer Product Safety Commission.[5] The NEISS is composed of approximately 100 hospitals selected as a stratified probability sample of about 5000 hospitals with emergency departments located throughout the United States.[6 7] The system includes very large inner city hospitals with trauma centers, as well as urban, suburban, rural, and children's hospitals. National estimates of injuries treated in hospital emergency departments in the United States and its territories were computed using data obtained from these NEISS hospitals. Basically, each case treated at a NEISS hospital is given a sample

Abbreviations: ASTM, American Society for Testing and Materials; CI, confidence interval; NEISS, National Electronic Injury Surveillance System

weight based on the inverse of the probability of selection. Then these sample weights are summed to provide national estimates overall and by selected characteristics.[7]

This study focuses on national estimates based on data from the initial visits of all 279 patients who were treated in NEISS hospitals for injuries related to paintball game activity, including those injured in organized paintball game facilities as well as in informal settings. Four patients under 7 years of age were excluded because no participant data were available for calculating rates. Also, 13 patients reported to be injured from an assault with a paintball gun and one patient reported to be injured during military training exercises were excluded.

For each study case, data were abstracted from medical records and coded by trained hospital coders on age, sex, diagnosis, body part affected, disposition at discharge from the emergency department, and locale where the injury occurred. A narrative description of the incident, as described in the medical record, was also recorded. Information in these narratives was used to code the cause of the injury (for example, shot by a paintball gun, struck by/against someone or something, struck by the paintball gun itself) and the activity (for example, playing paintball games, cleaning or handling a paintball gun) at the time of injury. Two injury researchers independently coded these variables based on a set of standard guidelines on the narrative description of the incident and then met to resolve any differences in coding.

Participant data used to calculate rates were based on national estimates of the number of paintball game participants in the United States, obtained from surveys by the National Sporting Goods Association.[8] The data were obtained on paintball game participants annually from 1999–2001 from a selected group of more than 300 000 households that was recruited to profile consumers regarding age, sex, region of the country, and other characteristics. A self administered questionnaire was mailed each year to a sample of 20 000 households asking about sports participation during the prior year by the male and female heads of household and up to two other household members who were at least 7 years of age. This sample of 20 000 was a random, weighted sample that assigned higher weights to population segments with lower survey return rates, so that the resulting return sample was representative of the population in the United States. Because the annual estimates of the number of participants varied, likely due to sampling error, we used the average annual estimate of the number of participants for the three survey years, and multiplied that by five to obtain the denominator for calculating the overall injury rates for the five year study period. Participant estimates by age and sex were only available from the 2001 survey. Therefore, we used the 2001 survey as the basis for calculating population estimates for age and sex groupings over the five year study period. In 2001, the overall response rate was 67.7%.

Non-fatal paintball game related injury rates per 10 000 participants are presented. Standard errors were not available for national estimates of the number of participants from the survey. Therefore, 95% confidence intervals (CI) of rates only considered variability associated with the national estimate of the number of paintball game related injuries treated in a hospital emergency department using NEISS data. PROC DESCRIPT of SUDAAN version 8.0.0 was used to obtain the associated standard errors for the numbers, percentages, and rates.[9] Estimates and rates per 10 000 participants were considered unstable if based on fewer than 20 sample cases, or if the coefficient of variation was greater than 30%. Unstable estimates and rates are noted in the tables with an asterisk.

RESULTS

From 1997–2001, an estimated 11 998 persons ages 7 years and older with paintball game related injuries were treated in hospital emergency departments for an average annual rate of 4.5 per 10 000 participants (table 1). The estimated number of persons treated for paintball game related injuries was more than three times higher in 2001 than in 1997. While the rate of those treated for these injuries per 10 000 participants was highest for adults ages 18–24 years (4.9 per 10 000 participants), the highest proportion of injuries (35.7%) occurred among those ages 12–17 years. Paintball game related injuries occur predominantly among males (94.0%).

Among all persons ages 7 years and older treated for paintball game related injuries, the two leading causes of injury were being hit by a paintball pellet (59.8%) and overexertion (17.9%) (table 2). Overall, the most common body part affected was the eye (42.7%), and the most frequent diagnosis was a contusion or abrasion (41.0%). Twenty three percent of paintball game related injuries were to the lower extremities, of which more than half involved the knee or ankle (61.9%). Strain/sprain (13.7%) was the second leading injury diagnostic category; most of these injuries were to the ankles (42.1%) and knees (27.2%). Most injured persons (95.5%) were treated and released from the emergency department.

A similar proportion of persons were reported to be injured in or around the home (28.4%) and at a paintball sports field (26.3%). The locale where the injury occurred was unknown for 37.7% of cases. About half of those injured reportedly sustain their injuries while actively engaged in paintball games. The activity was unknown for other injured persons.

Of injured persons who were shot with a paintball gun, 83.7% (95% CI 76.9% to 90.5%) sustained an injury to the head and neck area; of those injuries 69.1% (95% CI 59.3% to 78.8%) involved the eye only. The percentage of paintball pellet wounds to persons ages 7–17 year (76.9%) was 1.7 times higher ($p<0.0001$) than that for persons ages 18 years and older (45.5%) (fig 1). Overexertion or a fall while participating in paintball game activities was associated with 39.1% of injuries among persons ages 18 years and older, which was 3.1 times higher ($p<0.0001$) than that for persons ages 7–17 years (12.6%).

DISCUSSION

This study is the first to examine all types of paintball game related injuries treated in hospital emergency departments in the United States. Our findings demonstrate a risk of eye injuries during paintball game activities and support the need for eye protection. Among injured persons of all ages, the eye was injured in 42.7% of the cases. Many of those who sustained eye injuries were young people. Although data were not obtained in our study on the use of protective goggles or a face mask, previous research has demonstrated that injuries to the eye are more likely to occur when eye protective devices are not worn or are removed due to fogging.[1–3] Children and adolescents may be more likely than adults to exhibit high risk behavior by not wearing safety gear when participating in paintball game activities.[4 10] A previous study indicated that at least 85% of those suffering from an eye injury from contact with a paintball pellet were not wearing goggles at the time of injury.[11] In Canada, eye injuries among paintball game participants declined substantially between 1985 and 1992, partially from improved educational programs aimed at increasing the use of protective eye wear by players.[12]

The lower extremities were the second most common primary body part affected. Nearly one quarter of injured persons treated in hospital emergency departments had lower

Table 1 Estimated number of paintball game related injuries treated in hospital emergency departments, number of participants (in thousands) in paintball games, and injury rates and associated 95% confidence intervals (CI) by year of treatment, age, and sex for persons ages 7 years and older, United States, 1997–2001

Characteristic	Estimated No* (95% CI)	% (95% CI)	No of participants (in 1000)†	Rate/10000 (95% CI)
Total	11998 (8785 to 15211)	100	26700	4.5 (3.3 to 5.7)
Year				
1997	926 (–)*	7.7 (–)*	–	–
1998	1746 (1055 to 2436)	14.6 (8.8 to 20.3)	–	–
1999	2851 (1616 to 4086)	23.8 (13.5 to 34.1)	–	–
2000	2837 (1574 to 4100)	23.6 (13.1 to 34.2)	–	–
2001	3638 (2561 to 4715)	30.3 (21.3 to 39.3)	–	–
Age (years)				
7–11	1161 (531 to 1790)	9.7 (4.4 to 14.9)	2723	4.3 (2.0 to 6.6)
12–17	4284 (3298 to 5269)	35.7 (27.5 to 43.9)	9692	4.4 (3.4 to 5.4)
18–24	3333 (2008 to 4657)	27.8 (16.7 to 38.8)	6755	4.9 (3.0 to 6.9)
25+	3221 (1797 to 4645)	26.8 (15.0 to 38.7)	7530	4.3 (2.4 to 6.2)
Sex				
Male	11278 (8234 to 14321)	94.0 (68.6 to 119.4)	22775	5.0 (3.6 to 6.3)
Female	720 (332 to 1108)	6.0 (2.8 to 9.2)	3925	1.8 (0.8 to 2.8)

*Estimates may be unstable based on <20 cases or coefficient of variation ⩾30%.
†Estimates based on a 2001 survey conducted by the National Sporting Goods Association; annual participant estimates were not available to compute rates by year.

Table 2 Estimated number, percentages and 95% confidence intervals (CI) of paintball game related injuries treated in hospital emergency departments, by cause of injury, body part affected, diagnosis, disposition at emergency department discharge, location of occurrence, and activity, for persons ages 7 years and older, United States, 1997–2001

Characteristic	No* (95% CI)	% (95% CI)
Cause		
Shot by paintball gun	7173 (5740 to 8606)	59.8 (47.8 to 71.7)
Overexertion	2145 (1084 to 3206)	17.9 (9.0 to 26.7)
Fall	1111 (468 to 1755)	9.3 (3.9 to 14.6)
Other†	1569 (653 to 2484)	13.1 (5.4 to 20.7)
Body part effected		
Eye	5126 (3676 to 6575)	42.7 (30.6 to 54.8)
Other head/neck	1390 (834 to 1947)	11.6 (7.0 to 16.2)
Torso	1403 (589 to 2216)	11.7 (4.9 to 18.5)
Upper extremity	1291 (791 to 1792)	10.8 (6.6 to 14.9)
Lower extremity	2753 (1204 to 4303)	22.9 (10.0 to 35.9)
Unknown	34 (–)*	0.3 (–)*
Diagnosis		
Contusion/abrasion	4920 (3748 to 6092)	41.0 (31.2 to 50.8)
Strain/sprain	1640 (792 to 2488)	13.7 (6.6 to 20.7)
Laceration	1293 (732 to 1855)	10.8 (6.1 to 15.5)
Fracture	783 (336 to 1230)	6.5 (2.8 to 10.2)
Other‡	3362 (2244 to 4479)	28.0 (18.7 to 37.3)
Disposition		
Treated/released	11459 (8411 to 14508)	95.5 (70.1 to 120.9)
Hospitalized	447 (–)*	3.7 (–)*
Observation/ unknown	92 (–)*	0.8(–)*
Locale where injury occurred		
Home/farm/mobile home	3408 (1747 to 5069)	28.4 (14.6 to 42.3)
Public street	909 (–)*	7.6 (–)*
Sports arena	3153 (1492 to 4814)	26.3 (12.4 to 40.1)
Unknown	4527 (3294 to 5760)	37.7 (27.5 to 48.0)
Activity		
Playing paintball	6335 (3837 to 8834)	52.8 (32.0 to 73.6)
Other¶	703 (–)*	5.9 (–)*
Unknown	4959 (3826 to 6093)	41.3 (31.9 to 50.8)

*Estimates may be unstable because based on <20 cases or coefficient of variation ⩾30%.
†Includes struck by paintball gun, struck against something, burn, and cut.
‡Includes hemorrhage, internal injury, puncture, and other unspecified.
¶Includes handling paintball gun and other.

extremity injuries, mostly associated with overexertion. The findings suggest that the proportion of paintball game related injuries caused by overexertion or a fall was higher among participants ages 18 years and older. Age related declines in fitness or agility may be associated with these injuries since paintball games usually require running, frequent directional changes, and quick movements to avoid being struck by a paintball.

This study suggests that many of the persons treated for paintball game related injuries were injured playing at locations other than sports facilities (for example, in and around the home). Some states and municipalities have recently passed laws to regulate sales, transport, and use of paintball guns.[13] Most of these laws were designed to address the inappropriate use of paintball guns, such as for vandalism or assault. Evaluations of these laws are needed to assess whether they reduce paintball game related injuries.

The American Society for Testing and Materials (ASTM) has issued a Standard Practice for Paintball Field Operation used by most paintball facilities.[14] These voluntary standards include recommendations for clothing and personal safety equipment (for example, wearing long sleeved shirts, pants, and eye, ear, and face protection); paintball gun features (for

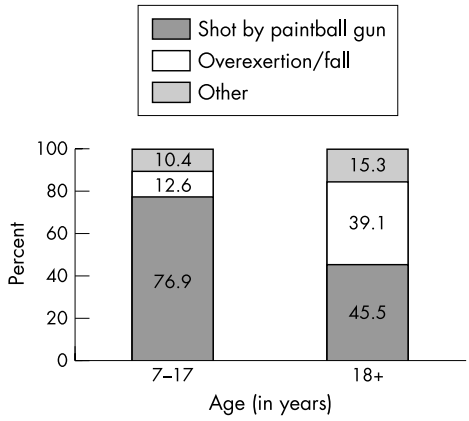

Figure 1 Estimated percentage of paintball game related injuries treated in hospital emergency departments by age and cause, United States, 1997–2001. Percentages do not sum to 100 because of rounding.

example, maximum velocity of 300 ft/sec, trigger guards, semiautomatic or pump action only, barrel plugs in place when not on playing field); safety signage (for example, marking playing fields and stating safety rules); and safer game areas (for example, marked boundaries and dangerous areas, absence of hazards such as barbed wire or broken glass, presence of floor surfaces with adequate traction). The standard also includes provisions for an emergency contingency plan (for example, first aid kit, cell phone to call 911), adequate judges during games, carbon dioxide fill stations, and adequate spectator and staging areas. The recommendations in the ASTM standard will need to be evaluated to determine their effectiveness in reducing injuries.

Although the annual number of paintball game related injuries increased substantially from 1997 to 2001, we were not able to determine if annual injury rates increased over time. This is because estimates of paintball game participants in the United States were not available for each of the five years included in this study. Population based data on the number of participants annually as well as other measures of exposure are needed to compute injury rates to further characterize trends and those at highest risk of injury.[15] Some of these measures include the distance between the gun and the injured person at the time of injury, the injured person's experience level, and the extent of exposure time (for example, frequency of playing) for each player.

This study has some limitations. First, while our preference would have been to provide cross tabulations of national estimates for body part affected by locale where the injury occurred and for body part affected by diagnosis, the number of sample cases was too small to provide stable estimates. Second, the location of occurrence could not be determined for more than one third of cases because of lack of information in the medical record. Finally, this study only included persons with paintball game related injuries treated in hospital emergency departments in the United States; many more persons with these injuries were likely treated in outpatient clinics or physician offices, or not medically attended at all.

IMPLICATIONS FOR PREVENTION

We found that paintball game related injuries occur among participants of all ages, with the highest rate among persons ages 18–24 years. The eye is the most vulnerable body part for sustaining injuries from a projected paintball. Also, many other injuries, especially among those participants ages 18 years and older, are caused by overexertion or a fall; these are likely the result of the active nature of participating in paintball games. Several public health strategies could help reduce the risk of paintball game related injuries, including training and educating players and referees, enforcing rules of engagement, ensuring proper use of personal safety gear and of paintball guns, providing a safe playing field, and implementing and enforcing state and municipal laws.

When involved in paintball games, goggles should be worn at all times to prevent eye injury. ASTM has developed specifications for goggles, and all goggles meet these ASTM specifications.[16 17] Goggles range in price and vary from single lens to thermal lenses, which are recommended by the American Paintball League. Participants should consider using goggle defogging agents. Additionally, the development and enforcement of rules preventing shots to the head in paintball games may be another means by which to reduce such injuries; however, due to the nature of the game, such rules may be difficult for players to carry out and for referees to enforce.

In paintball facilities, enacting and enforcing policies that require the use of additional protective gear such as knee pads and athletic shoes that protect the ankle and encouraging warm-up exercises might help prevent injuries from overexertion and a fall. However, use and effects of these interventions in paintball games need to be evaluated.

Prevention strategies to ensure the safety of adolescents and children participating in paintball games in informal outdoor settings need further development. Safety training for players and referees and adult supervision by parents, caretakers, or other referees could be helpful in reducing the risk of injury during ''backyard'' as well as facility games. Training and supervision should focus on strict enforcement of rules of engagement, use of protective gear, and a safe playing field.

Key points

- Paintball games are growing in popularity in the United States.
- Injuries occur among participants of all ages.
- To protect themselves and others from injury during paintball games, participants should follow rules of engagement, use recommended paintball guns and accessories, and wear proper protective equipment for the eyes, ears, face, and other areas of the body.
- Many paintball game related injuries occur in places other than paintball fields; children and adolescents should be supervised at all times when using paintball guns in informal outdoor settings as well as formal paintball game facility settings.
- While being hit with a paintball pellet was the most common cause of injury among children and adolescents, overexertion and falls were the most frequent cause of injury among adults. Prevention strategies are needed to reduce injuries from overexertion and falls.

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LACUNAE

Legal settlement for on-field soccer tackle

A player in the English soccer competition has settled a legal case of assault and battery on the football field by agreeing to pay the player he injured £250 000 pounds (US$480 000). The tackle that resulted in the case occurred six years ago. Although it did not result in a penalty in the game, it left the tackled player with a steel rod in his left leg and skin grafts from his buttocks to repair a hole in his ankle. His lawyers said doctors initially feared his leg might have to be amputated. It was claimed that the event ended the player's career. The settlement, to be paid by insurers, represented 10% of the claimed amount plus costs. The tackling player, categorised as someone who went beyond the boundaries, argues that he is innocent of extreme action. The settlement was made without admission of liability (submitted by Caroline Finch; from *The Age* (Melbourne), February 2004).

Reflective camels

Western drivers may moan about road humps, but motorists in Saudi Arabia have a more arresting kind of hump to cope with—the type attached to a camel. Half a million camels roam the Saudi deserts and a high speed collision with one is a serious matter. They cause 600 accidents a year, killing about 150 people, mostly at night. Although there are warning signs where camels often cross the road, Ali Al-Ghamdi and his colleagues at the King Saud University, Riyadh, will report in *Accident Analysis and Prevention* that the standard triangular sign with a pictogram of the beast has no effect. But by doubling the size of the sign and giving it a reflective background, they have persuaded drivers to shave 7 km per hour off their normal average of 86 km per hour (submitted by Peter Jacobsen).